



Dedicated to innovation in aerospace



UAS Integration Starts Now

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AT-One

AT-One is the ATM Alliance between NLR and DLR

Motivation and problem description

- UAS are becoming more and more in use in the military world
- In civil world: a lot of interest
- Now, they are restricted to fly
 - limited locations
 - permission to fly on case-by-case basis
 - segregated airspace
- Our goal is to fly the aircraft anywhere
 - VFR, IFR
 - file-to-fly
 - controlled and non-controlled airspace (class A to G)



Means to achieve the goal

- **Perform simulations with air traffic controllers**
 - to gain awareness with controllers of UAS issues
 - to learn what are the issues
- **To set up realistic scenarios in realistic environments**
 - normal operation in other traffic
 - emergency situations
- **We restrict to IFR and controlled airspace**
- **Two projects: SINUE and USICO**
 - international context – ensure acceptance
 - work in consortia

Research questions

1. What architecture do we need
2. What procedures do we need
3. What emergency procedures do we need

Experience from air traffic controllers
is crucial



Assumptions

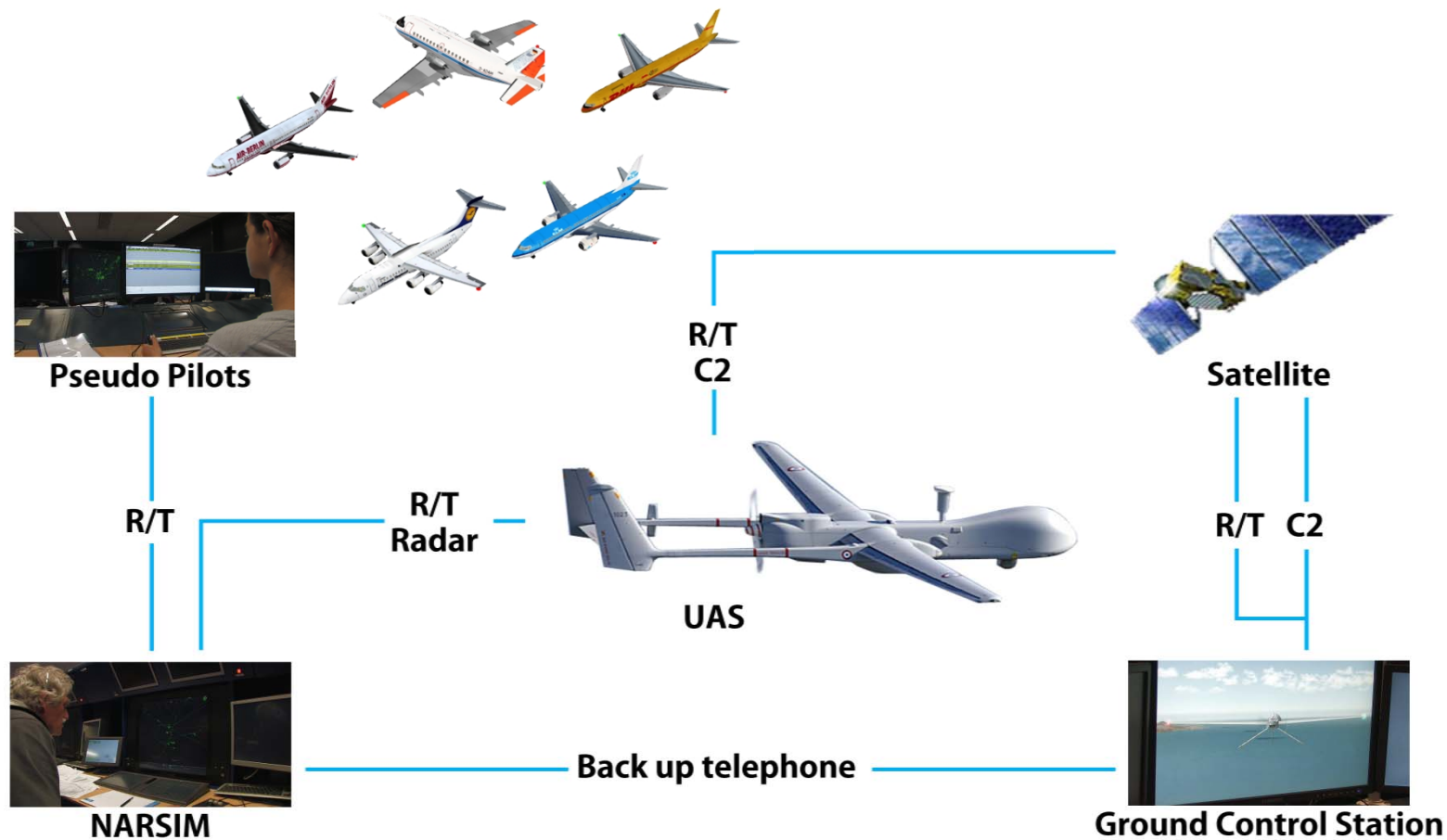
- Stay close to current day scenario for ATC
- Stay close to current day scenario for controlling the UAS (no autonomous flight)
- In an ATC environment means beyond visual line of sight. We will even assume BLOS (not only RLOS).
- Integration in traffic scenarios – existing scenarios can be used with insertion of one (or more) UAS



1st question: architecture

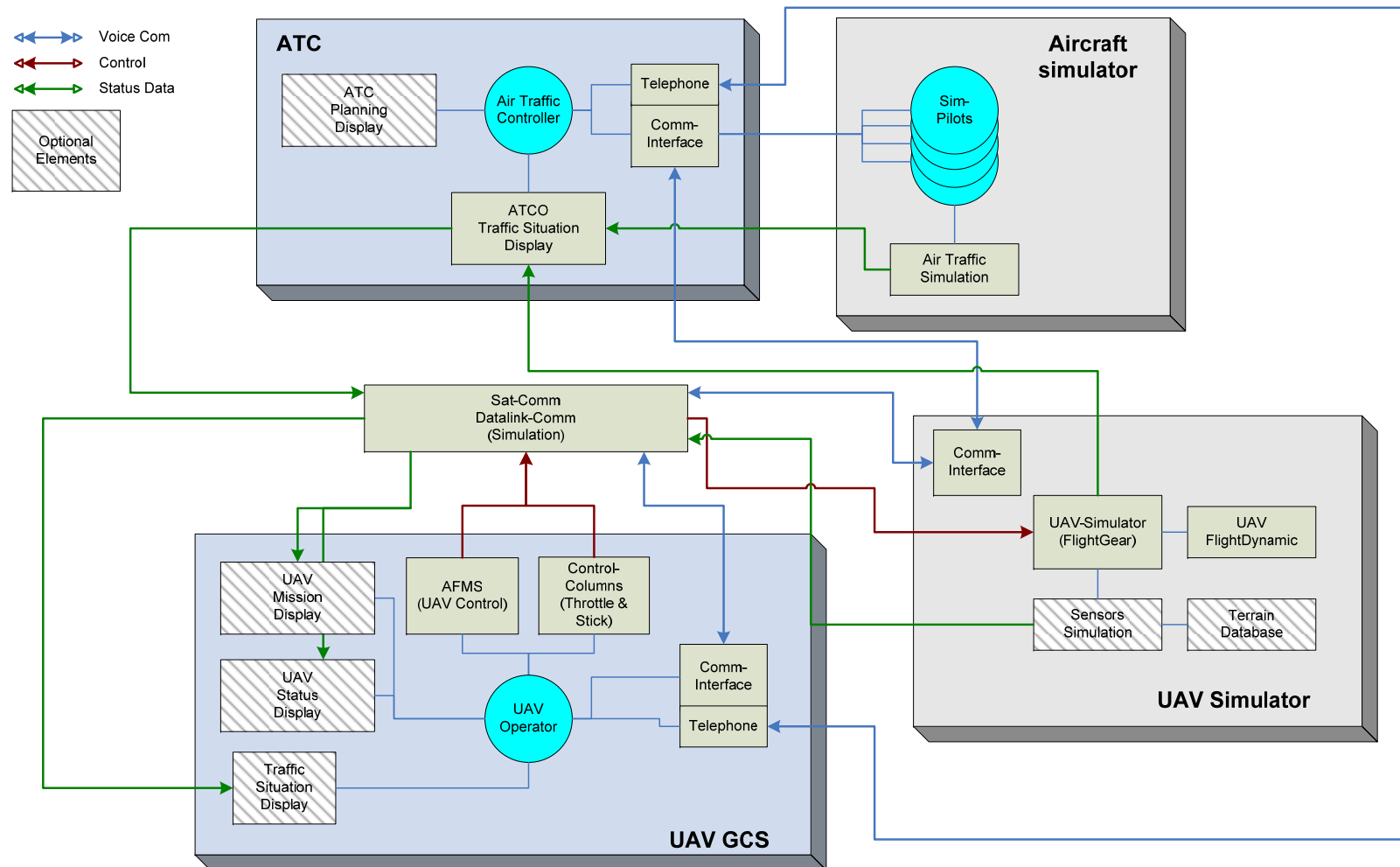
- **Many working groups are involved in setting up the necessary architecture (e.g. WG73)**
- **Main questions involve**
 - with an UAS, the pilot cannot look out of his window: DAA
 - no “feel” the vibration of the aircraft
 - no awareness of where to land/crash in case of emergency
 - how to use the available infrastructure, not only through communication via the aircraft, but also to use land infrastructure
- **Ground based pilot is not always a disadvantage: the pilot is able to communicate with ATC over a land line**
- **Considerations:**
 - adaptation of existing (ATC) systems
 - necessary on-board equipment (weight and sensitivity)
 - Line of Sight (VHF) vs. Beyond Line of Sight (SatCom)

Architecture used in the simulation



SINUE communication overview

Communication structure



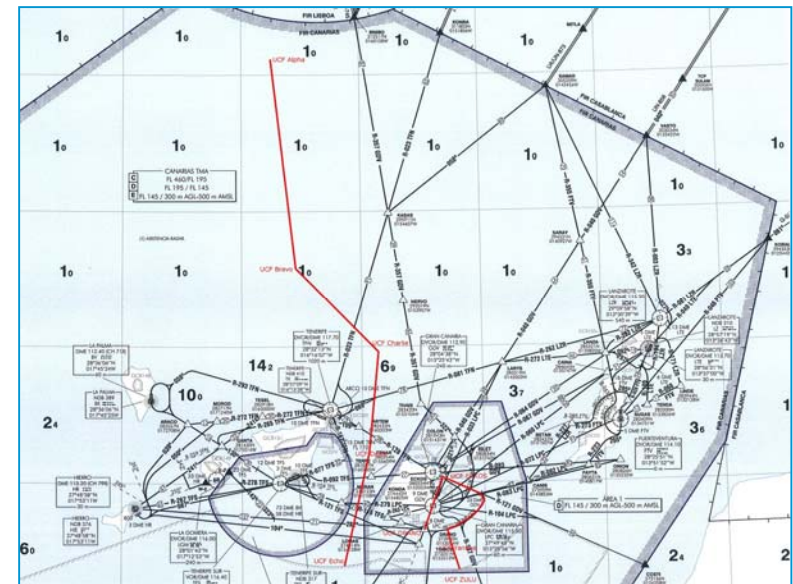
2nd question: procedures

- **Special procedures for UAS could be developed**
- **Considerations**
 - use of special routes
 - special call signs
 - special transponder codes
 - special symbology on ATC display
- **One may wonder how much “integration” is taking place in these situations**
- **As our aim is to integrate UAS in traffic, we decided to have the unmanned aircraft act like other aircraft**
 - only a dedicated call sign was used
 - special transponder codes were use for emergency situations

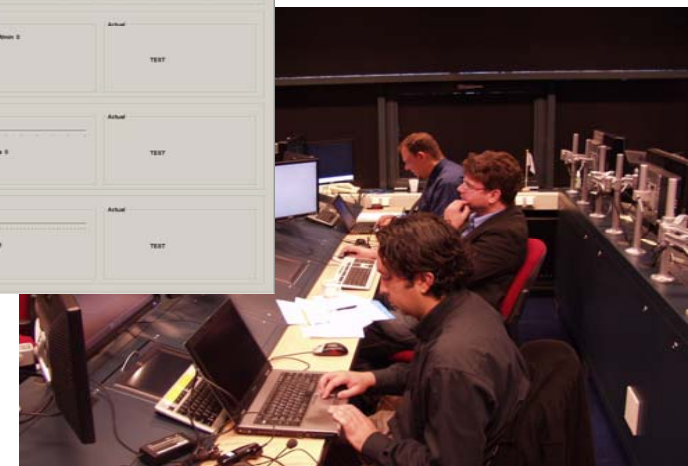
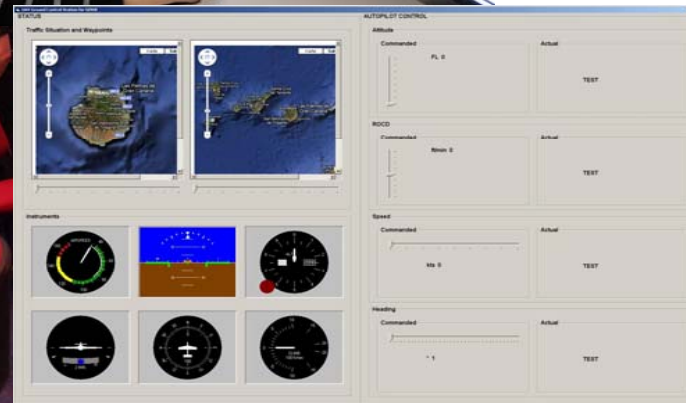
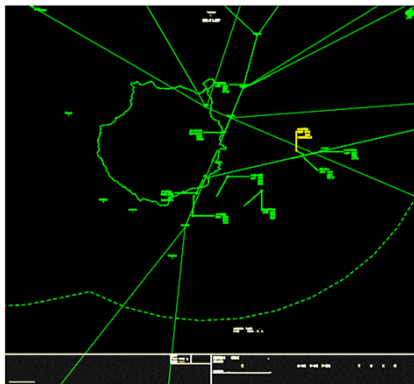
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- The diagram illustrates the Global Navigation Satellite System (GNSS) constellation. It shows the Earth at the center, surrounded by several orbits. Satellites are labeled with their names and frequencies. The orbits include GPS (NAVSTAR), GLONASS, Galileo, and BeiDou. The diagram shows the global coverage of these systems.

Behaviour of the UA in case of failure

- A “go home” manoeuvre is programmed
 - fly to the home base
 - fly to an alternate airport
 - climb in order to try to re-establish communication
 - crash in a crash area
- To reach the home area, a manoeuvre needs to be defined, which is safe and separates the UA from other traffic

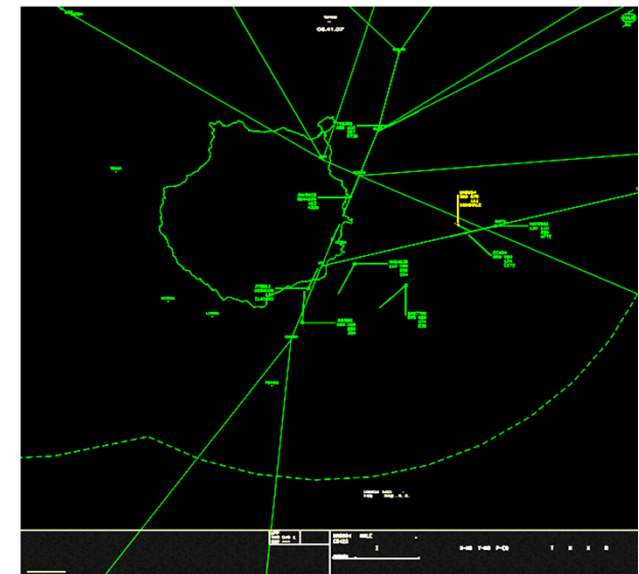


Experience from air traffic controllers



Human factors validation

- **ATCo**
 - callsign labelling of the UAS on the air traffic display
 - use of special emergency transponder codes
 - UAS flight performance
 - Workload
- **Communication with UAS pilot**
 - what to do in emergency situations
 - time delay in satellite communication
 - back up phone protocol
- **Two experiments**
 - Frankfurt area (USICO project)
 - Canary Islands area (SINUE project)



Means of verification

- Check the number of conflicts
- Questionnaire after each run
- Questionnaire at the end of the day
- Discussion session with
 - air traffic controller
 - UAS pilot
 - pilot that controlled the other traffic
 - route designers
 - experiment supervisor

Results

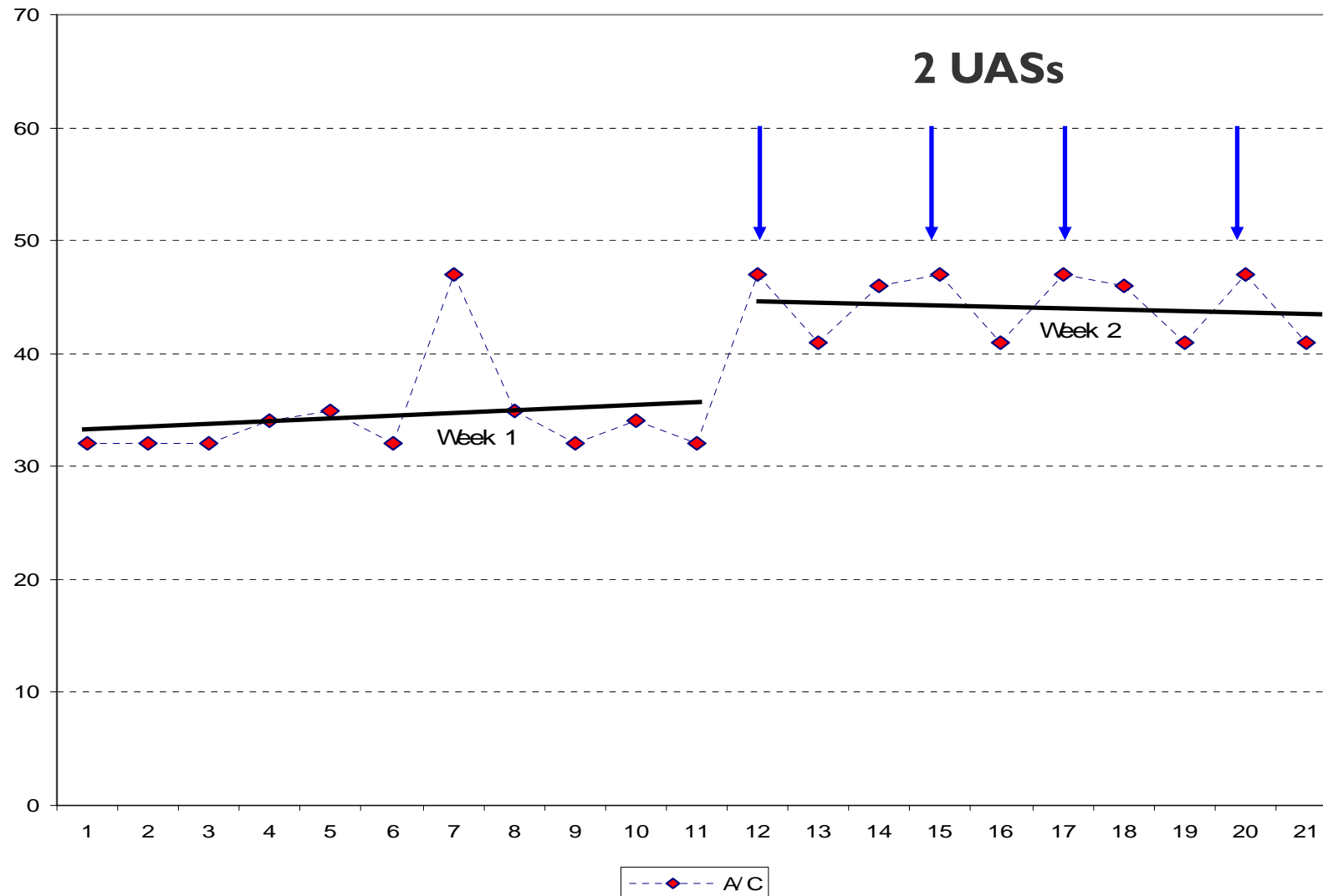
- **No need for further specialising SSR codes:**
 - 7600: comm loss
 - 7660: datalink loss, proceed as planned
 - 7661: datalink loss, return home
 - 7662: datalink loss, fly to emergency field
 - 7700: emergency
- **Fly home-procedure must be consistent with emergency procedures for manned aircraft**
 - indication of call sign (SSR code)
 - special go-around procedure on final approach
 - normal route diversion procedure (two minutes straight flight and then climb/descent towards the emergency route)
- **Use of the phone for backup communication is appreciated**
 - remote pilot must initiate the call
 - initially contacts ATC supervisor

Conclusions: UAS air traffic insertion

- We performed real time ATC simulations to prepare for real integration of UAS in the air traffic
- Show to controllers in each case how it will work, through real time simulation the safety case on procedures and emergency situations can be supported
- Design emergency procedures is necessary in consultation with ATC
- We have demonstrated the possibility!

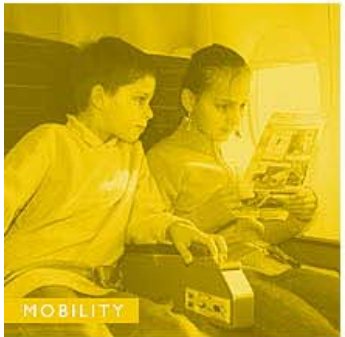
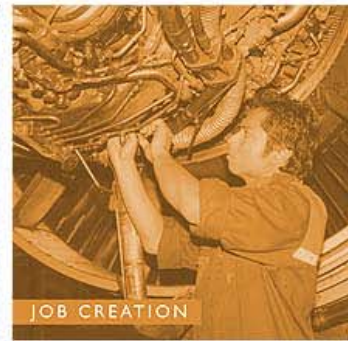


Workload of Controllers (USICO project)





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